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Comments of the Institute for Energy and Environmental Research on the Draft Environmental Impact Statement on the Yucca Mountain Repository (DOE/EIS-0250D)

by Arjun Makhijani, Ph.D.
23 February 2000

These comments of the Institute for Energy and Environmental Research (IEER) on the Draft Environmental Impact Statement on the Yucca Mountain Repository (EIS) are organized into two parts. Dr. Yuri Dublyansky, a geologist, has prepared comments for IEER on the EIS. His comments are attached. They are an integral part of the first portion of the following comments. Citations provided in that attachment will not be repeated here.

The Draft EIS of the Department of Energy (DOE) on the Yucca Mountain Repository is premature, scientifically unsound, fundamentally deficient, and improperly dismisses a crucial environmental justice issue. These conclusions are illustrated by the following points, which are discussed in more detail after the list:

1. The Draft EIS is premature because the basic scientific work needed to assess the environmental impact of the repository has not been completed. Some of it is still the subject of intense scientific controversy, research and debate. Essential questions must be resolved before the impact of the repository can reasonably be assessed.
2. The Draft EIS is scientifically unsound because it has ignored or improperly dismissed published peer-reviewed data, ignored lines of inquiry, not established a valid basis for uncertainty analysis, and failed to consider any redundancy in systems, which may result both in lower uncertainties and better containment.
3. The Draft EIS is fundamentally deficient because it has not considered some of the most significant environmental impacts, ignored relevant alternatives, and ignored many problems associated with human intrusion.
4. The Draft EIS has improperly dismissed a crucial environmental justice issue without due consideration of President Clinton's executive order on environmental justice.

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1. and 2. The EIS is premature and scientifically unsound

The presumption in the Draft EIS is that the repository will be unsaturated – that is it will not at any relevant time have a significant probability of flooding with water. As the attached comments by Dr. Yuri Dublyansky show, the DOE's assumption is unsound. The DOE's reasoning in summarily dismissing the evidence for repository flooding in the geologic past is based on misleading and selective use of information. There is a good deal of evidence indicating flooding of the repository. There is also some evidence of relatively recent flooding (in geologic terms). The entire Yucca

...1 Mountain repository program is based on the assumption of an unsaturated repository. Given the centrality of this issue, the DOE should re-issue a draft EIS with its analysis of the environmental consequences of such flooding, so that the public can evaluate it on its merits.

Moreover, as is noted in Dr. Dublyansky's comments, the DOE has ignored the ongoing work that it has commissioned and is being performed by Dr. Jean Cline at the University of Nevada, Las Vegas. This DOE-funded program of research followed the publication of a report on the subject by Dr. Dublyansky that was commissioned by IEER. The results of that work were published by IEER in December 1998. The DOE project aims to confirm or negate earlier findings of hydrothermal incursions of groundwater into the repository horizon as well as to determine the date(s) in the geologic past when such incursion(s) might have occurred. The preliminary data from this work confirm the earlier work of Dr. Dublyansky. The project has not yet determined any dates for the hydrothermal events. The UNLV research will not be complete until well into 2001. Yet the DOE plans to publish its final EIS in the year 2000.

With the major exception of geologists involved with the Yucca Mountain Project, there is now widespread agreement that at some time in the geological past there were likely to have been hydrothermal incursions into the Yucca Mountain repository region. One or more such incursions in the future would utterly alter the analysis of repository impacts. This is therefore a crucial factor in projecting the performance of the proposed repository.

Were the issue being considered a marginal one, this sequence might, in some circumstances be considered acceptable. However, the questions of saturation and time of saturation are the central ones in determining repository performance. The Draft EIS is therefore premature. It should be re-issued in late 2001, at the earliest, after the UNLV findings have been published,peer-reviewed andtheir significance for the proposed repository has been carefully assessed.

If a Final EIS is completed without the data and analysis on hydrothermal incursions being fully taken into account in the assessment of impacts, the FEIS will be so basically deficient as to be invalid.

Besides the issue of hydrothermal incursions, the DOE needs to take fully into account the potential for the metal canisters to corrode in relatively short time periods (say, a few hundred years or less) if the repository is unsaturated but far more humid than has been assumed. Further, under such circumstances, the DOE also needs to factor in the potential for the rapid disintegration of the borosilicate glass waste form due to hydration aging.[1] Finally, the DOE needs to factor in the potential for far more rapid migration of plutonium and other actinides than has been assumed.

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3. The EIS is fundamentally deficient

Both of DOE's "no action" scenarios are straw men designed to orient the decision to "yes" for Yucca. Scenarios need to be plausible at least.

Inadvertent human intrusion is more likely to occur into or near the repository location because of the scarcity of groundwater resources in Nevada and possibly because of mineral deposits in the general area. The impact of human inadvertent human intrusion needs to be more carefully considered. It is unlikely that barriers and markers would endure for thousands of years. While

[1] Arjun Makhijani, *Glass in the Rocks : Some Issues Concerning the Disposal of Radioactive Borosilicate Glass in a Yucca Mountain Repository*, prepared for the Nevada Nuclear Waste Task Force and the Nevada Agency for Nuclear Projects, Nuclear Waste Project Office, State of Nevada. Takoma Park, Maryland:Institute for Energy and Environmental Research, January 29, 1991.

...2 there are instances of monuments enduring for thousands of years, there are many more instances of monuments disappearing altogether. The EIS needs to have a more realistic assessment of inadvertent human intrusion problems and a fuller description of the potential impacts not only on the hypothetical intruders, but also on other members of the public, after the intrusion has occurred.

The "no action" Scenario 1 of institutional control for 10,000 years on site is absurd and without historical foundation. The second "no action" alternative assumes on site storage for 100 years and loss of control after that. It assumes that society will take no action to protect the plutonium or the waste. This is equally absurd, given that huge quantities of weapons-usable plutonium are present in the waste and that the radiation barrier to the recovery of the plutonium will be sharply reduced after a few hundred years due to the decay of cesium-137 (half-life: about 30 years).

DOE recognized in its EIS that these scenarios are unlikely and that society would consider other ways of handling this problem. It dismissed these as "speculative" (p. S29). This is a deeply flawed argument. First the DOE's "no action" scenarios are not truly "no action". Both scenarios would require the US government to take control of the waste and put in place institutional and other control measures. It will likely have to build new storage facilities. The true "no action" alternative would be to leave the fuel in the control of the utilities, where it is today. There are a number of downsides to this, as there are to every alternative. A scenario having downsides is not a bar to its consideration under NEPA. On the contrary, a part of the objective is to illustrate both the advantages and disadvantages, so an environmentally sensible decision can be made.

IEER believes that the EIS should consider the no action alternative of leaving control on-site with utilities, which may then be expected to minimize their liabilities in various ways, instead of the two spurious and entirely implausible scenarios that it has set up. Moreover, the calculation of the impacts of these scenarios is highly speculative. In IEER's view it is so speculative as to be without significant scientific merit. It cannot provide a rational basis for decision-making in a NEPA document.

Further, the EIS needs to consider the possibility that Yucca Mountain is found unsuitable in a more realistic framework other than a "no action" alternative. It is not speculative to say that alternative means of management and disposal would be considered if Yucca Mountain were found unsuitable. Some of these means are well-known and documented in the literature. For instance the 1983 National Research Council report on geologic isolation[2] examined a number of different geologic types and locations. As another example, IEER has published an entire plan of research and development so that alternatives may be considered within the framework of sound science and long-term management goals. The IEER plan is an integral part of these comments and is attached.

DOE should create a set of realistic alternatives in case Yucca Mountain is not found suitable. IEER recognizes that DOE cannot examine another specific repository due to legal restrictions placed upon it. However, as IEER's alternative waste management plan has shown, much can be done to define alternative paths to long-term management without considering other specific repository locations.

3 IEER applauds and appreciates the fact the DOE evaluated peak doses for up to 1 million years and did not restrict itself to the arbitrary time limit of 10,000 years in the draft EPA Yucca Mountain standard. The 10,000 year limit has been rejected more than once by the National Research Council and by many others, including IEER. This feature of the EIS should be maintained.

[2] National Research Council, Commission on Physical Sciences, Mathematics, and Resources, Board on Radioactive Waste Management, Waste Isolation Systems Panel, *A Study of the Isolation System for Geologic Disposal of Raradioactive Wastes*. Washington, D.C. : National Academy Press, 1983.

4 The DOE has not chosen the location of the maximally exposed individual conservatively. That individual should be located at the site boundary and not 5 kilometers away. IEER's comments on the EPA draft Yucca Mountain rule are attached and are an integral part of these comments on the Yucca Mountain Draft EIS.

5 The DOE's analysis that the primary radiological impacts would occur from the water pathway is not correct for collective population doses. The EPA Science Advisory Board report on carbon-14 emissions from Yucca Mountain showed that, while the individual doses from carbon-14 emissions would be tiny, the collective global doses would be immense. Based on the linear no-threshold hypothesis, which is the basis for current radiation protection standards, and which is also the modeling approach recommended in the BEIR V committee report[3], carbon-14 collective doses would be estimated to cause thousands of cancer fatalities.[4] These estimates cannot be ignored in the Draft EIS.

6 Moreover, the Draft EIS not only dismisses the potential for the repository to be saturated in the future; it does not discuss at all the possibility that upwelling contaminated water may outcrop at the surface (see attached analysis by Dublansky). Such an outcrop could contaminate large land areas, depending on the amount of upwelling water and the location of the outcrop. The DOE should consider land and surface water contamination impacts on the human population of such outcropping s well as underground water contamination due to repository flooding, in its evaluation of which pathway would be the one to deliver the maximum individual dose. The DOE should also consider the larger ecological impacts of outcropping of contaminated water. These could be diverse and vast.

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4. Environmental Justice

We do not believe that referring to a Supreme Court decision regarding Western Shoshone land is sufficient consideration of the environmental justice issue. The Supreme Court has historically made decisions that have reflected prevailing social opinions that have been highly discriminatory and unjust – as in its support of slavery, segregation, and internment of Japanese Americans. That these decisions have been unjust has been acknowledged by the Supreme Court in its reversals of such decisions after decades.

The fact the Western Shoshone themselves have not accepted any money in compensation for their land should provide enough basis for a deeper consideration of their claims. The basis for this consideration in an EIS rests both in the presidential order on environmental justice and in the historical record of Supreme Court decisions and reversals on issues relating to oppressed minorities in the United States. The consideration of this issue in depth does not mean that DOE is not "abiding by" a decision of the Supreme Court. It will simply put the Supreme Court decision in historical context. IEER believes that full consideration of the issue in a historical context is required in the EIS in view of the presidential directive on environmental justice.

[3] National Research Council, Commission on Life Sciences, Board on Radiation Effects Research, Committee on the Biological Effects of Ionizing Radiations, *Health Effects of Exposure to Low Levels of Ionizing Radiation : BEIR V.* Washington, D.C. : National Academy Press, 1990.

[4] United States Environmental Protection Agency, Science Advisory Board, *An SAB Report : Review of Gaseous Release of Carbon14 : Review, by the Radiation Advisory Committee, of the Release of Carbon-14 in Gaseous Form from High-Level Waste Disposal*, EPA-SAB-RAC-93-010. Washington, DC, April 1993.

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Comments of the Institute for Energy and Environmental Research (IEER) on the draft EPA standards for a Yucca Mountain high-level radioactive waste repository, 40 CFR Part 197. Federal Register. Volume 64, No. 166, August 27, 1999

Arjun Makhijani
November 23, 1999

8 The Draft EPA standard for the proposed Yucca Mountain repository, while containing some aspects that are in the direction of environmental protection, is fundamentally deficient in a number of procedural as well as substantive aspects. A final standard along the lines of the present draft will fail to ensure the protection of health and the environment for the time during which wastes disposed of in the repository will remain a
11 hazard to public health. IEER's main recommendations are:

- The EPA's choice of "reasonably maximally exposed individual" is fundamentally flawed. It should be replaced by a critical group of subsistence farmers, as discussed in Appendix D of the 1995 National Research Council Report entitled *Technical Bases for Yucca Mountain Standards* (the TBYMS report).
- EPA should discard its proposed time limit of 10,000 years for radiation dose protection. The time at which the dose limit must be met should be the time of estimated peak dose, whenever that might occur, as recommended in the TBYMS report.
- The EPA's choices of location for withdrawal of groundwater are too far (at least several kilometers) from the repository footprint. The assumed location of groundwater withdrawal should be at the downgradient edge of the repository footprint, unless the estimated contaminant concentration due to all sources, including Yucca Mountain is greater at another location.
- EPA should take into account all relevant non-cancer and synergistic health and ecological risks from repository construction and waste disposal in it, even if the National Academy of Sciences has not so far evaluated these risks. Specifically, EPA should evaluate non-cancer risks from carbon-14 releases.
- The suggested limit of 15 millirem per year is not protective enough. It has been set without taking due account of potential future groundwater contamination from radionuclides left in the ground due to past nuclear testing, future "sub-critical" tests, which are expected to continue indefinitely, some other potential radionuclide sources in the region, and some non-cancer risks that may be relevant in the context of the Yucca Mountain repository.
- EPA should specify that groundwater protection requires that the dose limit of 4 millirem not be exceeded taking into account the cumulative contamination from all potential radionuclide contaminant sources, including but not limited to the Yucca Mountain repository alone. The final Yucca Mountain standard should require strict conformity with the Safe drinking Water Act.
- EPA should require that the dose limit to the critical group correspond to the 99 percent upper confidence bound based on quantifiable parameters. This will build some room for unanticipated problems in a project whose performance assessment is likely to contain uncertainties and omissions that cannot be quantified.
- The EPA's inadvertent human intrusion scenario should be based on technology, such as laser drilling, which is foreseeable but which may not be commercial today.

Detailed comments and recommendations

1. The 1995 report of the National Research Council on Yucca Mountain Standards (TBYMS report)

The EPA was right to state that it not be completely bound by the TBYMS report. However, it is not sufficient to use this report merely as a "starting point." (F.R. page 46982). It is not, as the EPA has claimed, a question of following the National Research Council advice "mechanically" (F.R. page 46982), but using its "expert scientific guidance" with due consideration as Congress intended.

IEER believes that the EPA must treat the TBYMS report as authoritative unless:

- there was an internal disagreement on the panel, in which case the EPA must exercise its own well-considered scientific judgment,
- there are clear scientific, environmental or health protection grounds to reject the TBYMS report's analysis or recommendations and adopt a different approach, or
- the TBYMS report did not take into account certain health or environmental factors, thereby leaving open the door for the EPA to use its own scientific judgment.

2. Time for assessing dose limit compliance

The EPA's time limit of 10,000 years for assessing doses and risks is arbitrary. It is also contrary to the scientific advice in the TBYMS report that the EPA is mandated to take into account. Further, the TBYMS report's conclusion in this regard has precedent in an earlier report by a 1983 National Research Council panel on geologic isolation. One of the EPA's principal justifications, reference to 40CFR191, can be rejected out of hand. If 40CFR191 were a reliable guide to standards in the present case, new standards would not be needed for Yucca Mountain at all. Further, the quantity of long-lived radionuclides is far greater and the specific mix of radionuclides at Yucca Mountain is different from that in the Waste Isolation Pilot Project in New Mexico, where 40CFR191 is being used as the governing rule.

The EPA's reason that uncertainties beyond 10,000 years become unacceptably large is not a reason to stop at that time. On the contrary, it should be a reason to set a more stringent standard and to seek ways which uncertainties can be reduced. Present inadequacy of Yucca Mountain models is not an argument to abandon health protection of future generations. Making modeling uncertainties small enough is task of the Department of Energy (DOE). It is the job of the Nuclear Regulatory Commission to ensure that DOE has done it well. It is EPA's job to ensure that health and environment are protected.

The EPA's other argument for not extending the time frame beyond 10,000 years is that "[t]here are likely to be no exceptionally large geologic changes during that time" of 10,000 years (F.R. page 46994). In fact, this is an argument to extend the time frame and assess what the effect of such geologic changes might be, if the area is actually susceptible so such change during the anticipated period of risk.

Moreover, the EPA's requirement that events that have more than a 1 in 10,000 chance of occurring in the 10,000 years after disposal be considered is tantamount to requiring an examination of the effect of events that may occur millions of years after disposal (with higher expected values during these longer periods). Thus, the EPA is essentially agreeing with the TBYMS report that assessments of events for a time period on the order of a million years could be done, though with increasing uncertainty. It is generally acknowledged that estimates for long time periods are one of the most difficult aspects of repository performance assessment. But within that context, the choices should not be arbitrary, but rather geared to performance criteria for the period over which the repository might substantially affect the human environment (defined by the peak dose in this instance).

The bottom line is that the time of peak dose is the relevant time frame from the point of view of public health and environmental protection. The EPA's arguments are not based on sound environmental reasoning and are internally inconsistent. The EPA has not provided sufficient grounds to reject the TBYMS report's

conclusion that estimates could be made for up to one million years. Its rejection of the TBYMS report's recommendation regarding compliance at the time of peak dose is scientifically and environmentally inappropriate. The final standard should be revised to so that the maximum allowable dose is not exceeded at the time of estimated peak dose.

3. Choosing the critical group

The EPA's evaluation of the relative merits of the two approaches to choosing the critical group described in the TBYMS report is sound. The EPA correctly notes that the method in Appendix D of that report, which identifies subsistence farmers as the critical group, is both more straightforward and is better founded in precedent and current practice, including recommendations of the International Commission on Radiological Protection. However, the EPA has then illogically rejected the subsistence farmer critical group approach in favor of its own "reasonably maximally exposed individual" who would be "representative of a future population termed 'rural-residential.'" This is an inappropriate extension to populations far into the future of present-day rules that define hypothetical maximally exposed individuals relative to presently operating facilities. It is speculative and scientifically unsound.

Moreover, the EPA's implicit assumption that a part-time farmer of the future would not grow all his/her own food (F.R. page 46989) is an unwarranted extension into the long-term future of the present-day idea that subsistence farming has relatively low labor productivity. People in the future might choose to grow most or all of their own food in highly productive ways for health reasons, and have plenty of time for other income-producing or leisure activities. *The term "subsistence farming" in radiation protection should be interpreted solely as a person (or household) growing most or all of the food that they consume, without regard to the amount of time or income involved in farming and non-farming activities.*

One of the main reasons to use the subsistence farmer critical group is that it eliminates speculation about future lifestyles. Trying to define future population characteristics introduces unacceptable elements of speculation into dose estimates, vitiating the estimates to the point that they may have little value for protecting future populations. The EPA therefore should adopt the subsistence farmer approach to the critical group recommended in Appendix D of the TBYMS report. Its rejection of this approach in favor of a "reasonably maximally exposed individual" is not appropriate on scientific and environmental grounds.

4. Risk versus dose

The risk-based approach recommended in the TBYMS report needs to be translated into a dose-based approach for cancer risk in order to be given practical effect. Since the probability of cancer cannot be calculated using present techniques except through a risk coefficient or coefficients, setting a dose limit is a reasonable way for the EPA to incorporate cancer risk into the regulation. However, it is not sufficient for other risks (see below), for which different risk measures are likely to be needed. Specifically, the EPA should evaluate whether the health risk from non-cancer effects may be comparable to or greater than that proposed in its 15-millirem limit for radiation exposure set mainly by using cancer risk coefficients (apart from very limited consideration of some mental retardation effects of radiation exposure). A method for evaluation of all relevant non-cancer risks, such as birth defects or miscarriages, should be published for public comment, since the TBYMS report provided no guidance for such risks. The limits for radiation exposure should be reduced to reflect non-cancer risks and uncertainties in these risks at the present time.

5. Location of water resources relative to the repository footprint

The location for the source of the water used by the subsistence farmer critical group should be at the downgradient edge of the footprint of the repository, where the maximum radionuclide concentration can be expected. There is no scientific basis for the assumption that residences far into the future would not be closer than several kilometers away from the edge of the repository footprint (F.R. page 46989), or that water would not be drawn from near Yucca Mountain, even if they were. For instance, if the terrain at the foot of

Yucca Mountain is hospitable enough to accommodate a tunnel-boring machine, it can also accommodate a well-drilling machine for drinking and irrigation water. Transport of irrigation water for several kilometers is well within the bounds of current practice. Moreover, it is possible that the amount of groundwater available in the vicinity of Yucca Mountain may increase greatly in geologic time frames (see below).

6. Small incremental risks

The EPA should be more firm and explicit that it is rejecting the concepts of "negligible incremental dose" and "negligible incremental risk." The TBYMS report's recommendation of this concept for the specific example of carbon-14 was based essentially on cancer risk considerations. The TBYMS report did not consider many kinds of non-cancer risks that could arise from exposure to carbon-14 (see below). Hence, the EPA should explicitly reject the use of this concept.

Exposure to carbon-14 should be considered as an explicit problem for individual and population protection in the standard since there are non-cancer risks that may arise in certain groups from exposures that have hitherto been considered a very small. Further, the calculated population doses to the global population from a Yucca Mountain repository have been estimated to be very high – large enough in fact to result in an estimated 4,000 excess cancer fatalities over 10,000 years. This estimate was made by the EPA's own Science Advisory Board in 1993.[17]

The EPA should use the linear, no-threshold hypothesis even for very small doses. The fact is that all incremental doses are above a considerable background radiation dose. Therefore, even very small doses may produce proportionate effects, since any threshold that might exist may already be exceeded by the biological damage caused by natural background radiation and other background carcinogenic risk factors. The linear no-threshold hypothesis is the best public health and environmental approach available. It is standard practice in radiation protection throughout the world. Ignoring supposedly small incremental risks introduces an unacceptable element of arbitrariness into the standard setting process.

7. Dose to the critical group

The suggested EPA standard of 15 millirem is not protective enough since it allows very little margin for exposures from other nuclear fuel cycle activities. Even leaving aside new activities in the future, extensive underground nuclear testing at the Nevada Test Site has left behind a vast potential source term of long-lived radionuclides.

The potential source term for future groundwater contamination in the area is increasing. The Department of Energy is now conducting sub-critical tests, which do not create vitrified rock that might contain a part of the plutonium. Hence, sub-critical tests are likely to pose disproportionately large risks of groundwater contamination per unit of unfissioned plutonium involved.

The EPA should also estimate the potential plutonium burden in the underground environment from such tests and factor in plausible exposure pathways prior to setting a limit for Yucca Mountain exposures. Two other sources of potential exposure need to be taken into account – that from "low-level" waste disposal at Beatty as well as from "low-level" waste disposal on the Nevada Test Site by DOE. Given that groundwater is likely to continue to play a central role in the economic development of the region, the dose limits from a Yucca Mountain repository should be set low enough so that there is still room for economic development that may involve commercial nuclear activities.

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[17] *Review, by the Radiation Advisory Committee, of the Release of Carbon-14 in Gaseous Form from High-Level Waste Disposal*, EPA-SAB-RAC-93-010, Science Advisory Board of the Environmental Protection Agency, Washington, DC, April 1993.

The EPA should take other sources and pathways of exposure into account in a scientifically rigorous manner before deciding how much below a 25-millirem dose limit to set the Yucca Mountain standard. For instance, until recently, it had been the general assumption, based on official assurances, that these radionuclides would remain sealed in the vitrified rock created by the test explosions. The recent discovery that plutonium in colloidal form left over from one of the tests has migrated a mile from the test location, should cause a re-evaluation of the potential long-term doses to the public in the region.

In this context, it is worth noting some of the findings of an external peer-review of DOE's modeling of contamination migration from one area of the test site.[18] The review was commissioned by DOE. Here are some of its findings:

- "Of greatest concern to us is the virtual absence of site-specific data from the underground nuclear test areas where most of the contaminant release and migration are expected to take place. Such an absence of data is unusual for sites of suspected or potential groundwater contamination. This data deficiency throws into question the validity of the analysis of the fate of pollutants, and required corrective action at Frenchman Flat." (page 5)
- "...we do not feel that the actual uncertainty in the predictions [of contaminant transport] is adequately evaluated....The actual uncertainty is likely to be much larger than that calculated because a number of factors have not been adequately addressed or impose limitations on the analysis." (page 9)
- Official studies have considered "[o]nly radionuclides with unclassified source term data....We suspect that inclusion of these [long-lived] radionuclides [from classified source terms] will almost certainly increase predicted radionuclide doses from groundwater." (page 10)

The EPA's process for setting the maximum allowable dose should explicitly take into account these issues. Consideration of these sources is also important for groundwater protection (see below).

8. The maximum dose and the upper confidence bound

The maximum allowable dose in the draft EPA standard does not have confidence limit specified with it. A failure to specify the confidence level leaves the issue inappropriately ambiguous. The EPA's approach that there should be a "reasonable expectation" that the standard will be met is vague and unenforceable.

The EPA should use an approach of specifying that the dose limit to the critical group limit should be the 99 percent upper confidence bound, based on those parameters that can be quantified. An upper confidence bound requirement is appropriate because Yucca Mountain dose calculations will most likely have significant uncertainties associated with them that cannot be quantified. One way to deal with some of the uncertainty that cannot be resolved by present-day knowledge is to require that the dose limit to the critical group correspond to an upper confidence bound rather than the mean value for the critical group.

Given the unprecedented nature of high-level repository dose estimation, a 99 percent confidence bound is more appropriate than the usual 95 percent bound often used in statistical computations. Using an upper confidence bound as the critical group dose estimate for assessing compliance is especially important for Yucca Mountain.

The performance of Yucca Mountain, as currently estimated by the Department of Energy, depends mainly on a single feature – a metal canister in an oxidizing environment. There is essentially no back-up feature that would provide a comparable level of containment. This is a huge vulnerability that must be recognized and factored into the health and environmental protection standard setting process of the EPA. IEER does not agree with the EPA that the corrosion rates of the canister and other metal components "may be quantified with a high degree of accuracy and precision" (F.R. page 46998). Based on present data, it is not

[18] *External Peer Review Group Report on Frenchman Flat Data Analysis and Modeling Task, Underground Test Area Project*, ITLV/13052-077, prepared for the DOE by IT Corporation, September 1999.

even clear whether the repository will remain unsaturated for a few hundred thousand years. There is considerable evidence that the repository horizon has been flooded with hot water rising from below in the geologic past, with the time of such flooding being uncertain.[19]

9. Use of expert opinion

In making dose computations, the DOE and NRC may use expert opinion and advice, but they should not exclude public opinion and advice on this account. "Expert elicitation" (F.R. page 46997) done with "Delphi" studies in which experts are polled about parameters that cannot be well-quantified based on real world data is often little more than a compilation of opinions dominated by an insiders' club. Expert elicitation should not be used to estimate parameters using Delphi surveys or similar techniques. This restriction should be specified in the EPA standard because Delphi type of techniques can create more problems than they solve and, moreover, exclude the public from vital areas of debate. Expert opinion provided in the context of open scientific and public debate in public hearings is greatly preferable to Delphi type approaches, especially for the most difficult questions. IEER recommends that all expert opinion and the documents on which it is based should be public.

10. Non-cancer risks

EPA has not given appropriate consideration to non-cancer risks and has failed to take into account the limitations of the 1990 National Academy of Sciences report (the BEIR V report), which is the principal basis for its discussion on this subject. The BEIR V study omitted most non-cancer effects and even omitted consideration of a variety of genetic effects. It acknowledged these limitations.

While the NAS may or may not consider all relevant effects in a specific scientific study, the EPA must take into account all relevant non-cancer effects. For instance, since carbon-14 may be released from an unsaturated repository at Yucca Mountain (in contrast to estimated releases from saturated repository locations), its non-cancer should be taken into account.

The National Academy of Sciences Committee on the Effects of Ionizing Radiation is due to re-study the effects of low-level radiation (the BEIR VII committee). The chairman of the BEIR VII panel, Dr. Monson, assured IEER during the public comment period on the second day of the first meeting that the issues raised in an IEER letter (see below), will be considered as seriously as if they had been raised by a member of the committee. The letter raises health issues that were ignored in the BEIR V report. The letter, along with the list of signatories, is attached as an integral part of these comments. The EPA should consider all non-cancer and synergistic effects relevant to Yucca Mountain. All radioactive and non-radioactive toxic materials that may be released into the human environment from a Yucca Mountain repository should be evaluated. These include greater than Class C wastes, highly enriched naval spent nuclear fuel, foreign research reactor spent fuel, and materials that are expected to be used in repository construction, canisters, and other engineered barriers.

11. Groundwater resource protection

The EPA has proceeded appropriately in including the groundwater sub-limit of 4 millirem in its proposed standard. IEER strongly supports this inclusion. However, the proposed 10,000-year time limit on this protection should be discarded in favor of time of peak dose, as discussed above for the overall dose limit. An approach using effective dose equivalents can be used to set combined limits for beta- and alpha-emitters in a conservative way, so that all plausible combinations of releases of radionuclides would result in drinking water doses less than 4 millirem per year.

[19] Yuri Dublyansky, *Fluid Inclusion Studies of Samples from the Exploratory Study Facility, Yucca Mountain*, Nevada, Institute for Energy and Environmental Research, Takoma Park, Maryland, December 1998.

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The 4 millirem sub-limit is an essential element in the broader goal of protecting drinking water supplies. However, the EPA has left the NRC and DOE with a loophole in that it would allow these agencies to consider the maximum contaminant levels (MCLs) to apply to a "representative amount of groundwater" (F.R. page 47002). In the four scenarios that the EPA considers, the closest point for determining groundwater purity is 5 kilometers from the repository. The others are 18, 20, and 30 kilometers from the repository.

The controlled area for the repository can extend at most 5 kilometers from the repository. The Safe Drinking Water Act (SDWA) therefore applies at all locations more than 5 kilometers from the repository and to many locations that are closer. Therefore, the EPA must discard scenarios at distances greater that 5 kilometers, unless it can be shown that they would have higher concentrations of radionuclides. Further, even a distance of 5 kilometers is unacceptably far from the repository footprint. The DOE cannot reasonably claim to maintain such a large "controlled" area after repository closure. The assumed withdrawal point should be at the downstream edge of the repository footprint, which at the present time is projected to be about 1 kilometer from the center of the repository.[20] There is not and cannot be a rational basis for violating the requirements of the SDWA. A Yucca Mountain standard that is inconsistent with the SDWA is necessarily arbitrary and capricious.

The EPA has assumed that the water withdrawal scenarios should "reflect the current, general lifestyles and demographics of the area, but not be rigidly constrained by current activities " (F.R. page 47002). The EPA's assumptions are arbitrary and speculative in that they constrain future lifestyles. Given mounting evidence that groundwater has risen and flooded the repository level in the geologic past, the EPA should factor in the potential that there may be a large volume of highly contaminated water at the edge of the repository footprint. This is because a flooded repository could cause a far more rapid and extensive release of radionuclides than is now projected for an unsaturated repository. Moreover, given the uncertainty about future climate, the current availability of water near Yucca Mountain should not constrain the standard setting process for groundwater protection. The MCLs should be determined at the downgradient edge of the repository footprint and not several kilometers away. Modeling considerations based on low water volume available today should not be a principal factor in decision-making on the withdrawal point for the water.

The requirement in the draft standard of a "representative amount of groundwater" appears to be inconsistent with the SDWA. The smallest public water system whose groundwater is protected under the SDWA may have as few as 15 connections or supply 25 people. The EPA should make its Yucca Mountain standard fully consistent with the SDWA. The final rule should protect the smallest potential public water supply as defined in the SDWA.

Finally, the EPA should specify that the sub-limit of 4 millirem for drinking water refers to all sources of man-made radionuclides, including any radionuclides that might migrate to the edge of the repository footprint from the Nevada Test Site (see discussion above about overall dose limit). If the migration of radioactivity from other sources combined with the Yucca Mountain source term is estimated to produce higher concentrations of radionuclides in groundwater at another location, then that location should be chosen for application of groundwater protection standards. Any other approach would not be consonant with the SDWA, which aims to protect groundwater as a resource.

12. Deliberate human intrusion

The EPA has not considered the risks of deliberate human intrusion following the TBYMS report advice that "it makes no sense...to try to protect against risk arising from conscious activities of future human societies" (cited on F.R. page 46999). This reasoning omits one very crucial consideration. Current US policy is that

[20] Office of Civilian Radioactive Waste Management, *Draft Environmental Impact Statement for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE-EIS-0250D, Washington, DC, July 1999, vol. 1, page 3-27, Figure 3-10.

such intrusion would be highly undesirable. Therefore, the EPA should specify that the repository should have features that would reduce, to the extent possible, the likelihood of deliberate human intrusion.

13. Inadvertent human intrusion

The EPA's assumption that technology similar to present-day commercial technology would be used for drilling in case of inadvertent human intrusion is inappropriate. Technologies currently under development include cutting of rock with high-powered lasers. Such technologies would greatly change the economics and feasibility of drilling in many areas and are also likely to result in far easier penetration of engineered barriers than is assumed in the EPA scenario for inadvertent human intrusion. The EPA should assume that the costs of drilling to the repository level in the not too distant future (a few decades) will be far lower than those at present and, moreover, that it will not be difficult to penetrate the canister. In other words, the EPA's scenario for inadvertent human intrusion should be based on technologies, such as laser rock cutting, that are foreseeable but not necessarily economical today.

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Comments on Draft Environment Impact Statement on Yucca Mountain, DOE/EIS-0250D

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Draft EIS does not analyze the potential impact of inundation of the repository zone by upwelling water

Draft EIS acknowledges that inundation of the repository zone by upwelling water, if happens, would have great impact on the long-term repository performance.[1] The possibility of such inundations was suggested by a number of scientists (Szymanski, 1989; Hill et al., 1995). Draft EIS explicitly states, however, that "*DOE does not agree with the inundation scenario*" (p. 5-15). This dismissal heavily rests on the findings of the 1992 NAS/NRC panel (National Research Council, 1992). The latter document is outdated, because much new data have became available since 1992. Below we summarize some of this evidence.

Fluid inclusion evidence

By rejecting "inundation scenario", DOE rejects new scientific information indicating the presence of waters with elevated temperature in what is now Yucca Mountain unsaturated zone in the past, obtained by studies of fluid inclusion in secondary minerals[2]. "Justification" of this rejection is given on pp. 3-49 – 3-50 of the Draft EIS as follows: "*DOE, given the opportunity to review a preliminary version of the report, arranged for review by a group of independent experts, including U.S. Geological Survey personnel and a university expert. This review group did not concur with the conclusion in the report by Dublyansky (1998 all)...*"

The quotation above reflects lack of objectivity in the DOE's handling of the controversy. First, experts who conducted the review for the DOE may hardly be called "independent", since all these scientists were promoting the "non-inundation" scenario for years[3]. Second, it is unfair and misleading not to mention written opinions of three truly independent experts from the Europe (selected for their outstanding scientific expertise in fluid inclusions and non-involvement in the Yucca Mountain studies)[4], attached to the report. All three reviewers concurred in the opinion that the fluid inclusion work is of high quality, and interpretations are reasonable.

[1] "*There has been no analysis to determine the effect; however, if such an event occurred, the long term impacts would probably increase greatly.*" (p. 5-11)

[2] Dublyansky and Reutsky 1995 & 1998; Dublyansky et al 1996; Dublyansky 1998-a & -b.

[3] Authors of the review, arranged by DOE are: J.Whelan, J.Paces, B.Marshall, Z.Peterman, J.Stuckless, L.Neymark of USGS and E.Roedder of Harvard University.

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Further, the U.S. NWTRB has agreed with the "thermal water" interpretation of the fluid inclusion data.[5] Finally, a DOE-sponsored verification fluid inclusion research project presently underway at University of Nevada at Las Vegas, UNLV, has already (as of July, 1999) confirmed the presence of the two-phase fluid inclusions, yielding elevated homogenization temperatures in secondary calcite and quartz from ESF.

Other evidence

Besides fluid inclusions, the presence of hot waters in what is now unsaturated zone at Yucca Mountain is suggested by a host of other methods.

a). The USGS geologists inferred elevated, up to 120 °C, temperatures for paragenetically early secondary silica from ESF on the basis of stable isotopic studies.[6]

b). Based on yet another method, structural studies of calcite, Mary Beth Gray with co-authors (contractors to NRC) concluded that calcite in fault rock in the ESF were formed at elevated temperatures (probably, 150-200 °C), and there have been more than one event of calcite deposition (Gray et al 1998).

c). Terry Else with co-authors (1999) have found viable moderately thermophilic calcite-depositing bacteria (temperatures of habitat 40-60 °C) in calcite sample that yielded homogenization temperatures of 35-50 °C; adjacent bedrock tuffs did not contain such bacteria.

d). Preliminary data on stable isotopic gradients in surficial calcite at Yucca Mountain suggest the progressive evaporation, CO_2 degassing and perhaps cooling – features consistent with travertine origin and inconsistent with pedogenic origin of these deposits (Dublyansky & Szymanski 1996; Dublyansky et al 1998). Prof. John Valley, who evaluated this work for the U.S. NWTRB, concurred with this interpretation (with one reservation that the presence of these trends needs to be verified).[7]

Hydrothermal activity at Yucca Mountain – Summary

The status of the issue was best summarized by former consultant to U.S. NWTRB, Prof. Robert Bodnar, at the 1999 Spring Meeting of the American Geological Society in Boston, Massachusetts: "*Those scientists who have examined the recent data are in general agreement that waters of unknown but, presumably, deep origin have entered the repository horizon at some time during the geologic past. ... The*

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[4] Independent experts who evaluated Dublyansky 1998 report are: Dr. Larryn Diamond, University of Leoben, Austria; Dr. Bruce Yardley, University of Leeds, UK; and Dr. Jean Dubessy, CNRS, France.

[5] "*... fluid inclusions found in mineral deposits at Yucca Mountain do provide direct evidence of the past presence of fluids at elevated temperatures ... in the vicinity of the proposed repository*" (letter of the Chairman of the U.S. NWTRB Jared Cohon to Acting Director of the U.S. DOE Office of Civilian Radioactive Waste Management Lake Barrett; July 24, 1998, p. 2)

[6] "*Delta-^{18}O values of the silica phases quartz, chalcedony, and opal indicate that some of the early massive-silica-stage phases must have formed from heated water...*" Whelan et al. 1998, p.21.

[7] "*These trends deserve close examination. If such trends are reproducible and are in fact different from local elevation effects, this would be strong evidence favoring progressive evaporation and CO_2 out-gassing (and perhaps cooling) as fluids move down slope.*" Letter from Prof. J.Valley to L.Reiter of NWTRB; Dec. 18, 1997. p.4.

9... *problem as it relates to the suitability of Yucca Mountain as a nuclear waste repository concerns the timing of fluid infiltration.*" (Bodnar 1999).

Elevated temperatures of secondary minerals deposition imply inundation of the Yucca Mountain unsaturated zone by upwelling water, provided two alternative sources of heat – residual heat of cooling bedrock tuffs and conductive heat transfer from deep-seated magmatic bodies – are ruled out. In the case of Yucca Mountain this requirement is met. Different researchers at different times have ruled out magmatic rocks as a potential source of hydrothermal activity at Yucca Mountain.[8] Isotopic dating by USGS researchers have shown that the oldest secondary minerals at Yucca Mountain were deposited 2 to 3 million years after the emplacement of the tuffs (Neymark et al 1998; Whelan and Moscati, 1998), which means the latter have already cooled down.

Timing of hydrothermal inundation

Frequency of occurrence of the hydrothermal activity and, therefore, the probability of its occurrence in the future cannot presently be established with confidence due to lack of the data. The DOE-sponsored Project[9] which is presently underway at University of Nevada at Las Vegas, will, hopefully, substantially advance our knowledge on the timing of hydrothermal activity at Yucca Mountain.

Nevertheless, there is already enough evidence suggesting that thermal fluids were present in the repository zone, constantly or intermittently, during the extended time span of ~9-10 million years, with youngest occurrences being only few thousand years old. These young isotopic ages have been measured for calcite from the ESF by the USGS researchers (e.g., Paces, et al 1996)[10]. Based on the preliminary data, the hydrothermal activity has probability of occurrence greater than the lower limit of 1×10^{-8} per year adopted by DOE as the level of concern (DOE 1998, p. 4-81).

Why it is important?

Water is the primary means by which radionuclides disposed of at Yucca Mountain could reach the accessible environment. The present repository concept critically relies upon the following factors: (a) small amounts of water (seepage in repository drifts) that may contact waste canisters; (b) small fraction of waste canisters that would contact with this water (because seepage is restricted to individual fractures); (c) high

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[8] "*Silicic volcanism located close enough to Yucca Mountain to have provided heat to the local hydrologic regime ended more than 11 Ma. Magma bodies below larger calderas (>10 km diameter) cool slowly and may be heat source for up to 2 Ma (Wohlentz and Heiken, 1992). Calculations based on theoretical cooling model (Smith and Shaw, 1978) indicate that magma chambers associated with calderas of the central zone of the Southwestern Nevada Volcanic field would have completely crystallized and cooled to ambient temperature several million years ago.*" Flynn et al., 1995, p. 27.

[9] **The project' term begun in April, 1999 and is scheduled to end by April, 2001.**

[10] The authors interpret this calcite as being deposited from rain waters percolating downwards through interconnected fractures. Recent results of Dublyansky (1999) and UNLV Committee have shown that 40 to 70 % of calcite from the

9... corrosion resistance of waste canisters in the predicted repository environment (moderate temperatures, oxidizing water, etc.); and (d) long pathway between the repository and accessible environment (including 175 to 365 m of the unsaturated zone beneath the drifts and about 20 km of saturated-zone flow to Amargosa Valley; with dispersal of radionuclides along the way).

However, if inundation scenario is considered, these factors are not the most important ones, for the following reasons:

Amount of water, contacting waste canisters. Instead of small amounts of seepage water contacting some waste canisters, all canisters will be completely submerged in water with composition totally different from today's meteoric water.

Corrosion resistance of waste canisters. Since the composition and the temperature of upwelling water will differ from meteoric water, the present assessment of waste package degradation rates cannot, therefore, be used for such dramatically different environment.[11] Preliminary data indicate that corrosion-resistant component of the base-case canister, alloy C-22, "*...is susceptible to localized corrosion ... when wet in a critical temperature range. If C-22 remains passive in this range, its anticipated life, prior to penetration, is thousands of years. If it is not passive, then its life, prior to penetration, is as little as a few tens of years*" (Whipple et al., 1998).

Long radionuclide pathway. Long pathway of water, contaminated with radionuclides from repository zone through 175 to 365 m of the lower part of the unsaturated zone, and then through some 20 km of saturated zone to the extraction wells in Amargosa Valley, will be replaced by a 200 to 425 m-long "shortcut" right to the land surface, where these waters would discharge as springs.

"Hot repository" consequences. If inundation occurs during the period when the repository zone is still hot due to the radioactive decay (a period that may last several thousand years), the consequences may change dramatically. Much will depend on the temperature of rocks and waste canisters, with which water comes into contact. This temperature will depend on time elapsed since emplacement, as well as the chosen thermal load. A set of scenarios may be constructed for water invasion in the repository zone when: (1) the temperature is well above water boiling point; and (2) when it is below boiling, but still higher than the temperature of upwelling fluids. Vigorous boiling and steam venting may be envisaged for the first scenario and enhanced convection of water for the second. Both these scenarios envisage faster failure of the canisters,thereby enhancing the ability of radionuclides to migrate.

ESF (including calcite from some occurrences dated by USGS), as well as some quartz, contain two-phase fluid inclusions indicating elevated, up to 60-80 °C, depositional temperatures.

[11] "*No rational materials selection can be made without knowledge of the characteristics of the waters in contact with the waste packages. These characteristics include: temperature, pH, Eh and ionic concentrations (Cl, SO_4, NO_3, CO_3, Fe^{+++}, Ca, etc.)*" Third Interim Report of the Peer Review Panel on the TSPA 1998.

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Summary on inundation scenario

We have demonstrated that:

a. There presently exists significant body of evidence, indicating that inundation of the repository zone by upwelling hot waters.

b. The ages of these events are presently not known with certainty; extensive preliminary data indicate, however, that they occurred intermittently between 9 million years and 8 thousand years ago.

c. Based on the present evidence, it is reasonable to conclude that the probability of occurrence of inundation is greater than the 1×10^{-8} per year DOE level of concern, which means that the hydrothermal hazard probabilistic analysis must be carried out.

d. Potential consequences of inundation of the repository filled with high-level nuclear waste may be disastrous for the environment and people.

e. Draft EIS does not consider the inundation scenario.

In our judgement, the failure to consider this important scenario makes the present Environmental Impact Statement completely inadequate and cannot be used for evaluating real environmental impact of the planed facility. "Inundation" issue must be explicitly resolved prior to any decision regarding the fate of the Yucca Mountain site.

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Closing remark - A fiasco rehearsal

Draft EIS (as well as released earlier Viability Assessment) is a model illustrating how critical decisions regarding the fate of nuclear waste will be made, and on what sort of science these decisions will be based. Having spent more than 15 years and several billion dollars to characterize the Yucca Mountain site, DOE and its contractors have produced tremendous amount of highly technical information. It is contained in millions of pages of reports and publications. Final Environmental Impact Statement, as well as all other documents that will provide basis for legal decisions must be based on careful evaluation of all pertinent information contained there. It is exceedingly important not to leave any information that has bearing on the performance of the repository beyond the scope of the analysis.

Decisions regarding what is important and what is less important and may, therefore, be omitted, can only be made by highly qualified professionals. We find it incredible that among 30 members of the Draft EIS preparation team only one has a degree in geology.[12] We do not believe that one Bachelor of Science, however brilliant he may be, may be put in position of being responsible for evaluation and compilation of 15 year-worth work of several organizations and tens of researchers that cover substantial number of very specific and intricate fields of Earth Sciences.

[12] Jeffrey McCann; B.S., Geological Sciences, 1980. US DOE 1999, pp. 13-1 – 13-7.

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September 3, 1999

Richard R. Monson M.D., Chair
c/o Rick Jostes, Staff Officer
Committee on the Health Risks from Exposure to Low Levels of Ionizing Radiation (BEIR VII)
National Academy of Sciences
2101 Constitution Avenue, NW
Washington, D.C. 20418

Dear Dr. Monson,

We are writing in connection with your committee's work on assessing the effects of low-level radiation in the form of the Biological Effects of Ionizing Radiation (BEIR) VII review.

We are pleased that the BEIR VII Committee has set out to "consider a large amount of published data ... concerning the risks to humans of exposure to low levels of ionizing radiation" (BEIR VII Project Scope). We expect that, as part of this work, the Committee will examine conflicting evidence and interpretations in the process of identifying biological effects and risk factors. We look forward to following closely the Committee's deliberations throughout this important process and to participating in them.

The work of past BEIR Committees has been influential in setting the tone and terms of the scientific debate on the issue and in the radiation standard-setting process. Therefore, we believe it is crucial that the full range of information and issues regarding the health effects of ionizing radiation be considered. The BEIR V report considered only risks of cancer, some aspects of genetic damage (though it did not estimate risks of "diseases of complex genetic origin, which are thought to comprise the largest category of genetically-related diseases," p. 4) and mental retardation arising from in-utero exposure.

It is important that the BEIR VII process address the full range of risks that have not been conclusively evaluated so far. This should include risks that have come to light since the BEIR V report (such as the combined effects of radiation and hormonally-active agents, also called endocrine disrupters) as well as issues that could have been addressed in BEIR V, but were not. We have compiled a list of some of the most crucial issues that we believe you should address. These issues are as follows:

- **Effects of radionuclides that cross the placenta:** This should include consideration of the effects on the developing fetus itself (e.g. miscarriages, malformations, and developmental effects other than mental retardation) and the effects on relevant organs at critical periods of fetal development. This study of health effects on the developing fetus should specifically include effects on development of specific organs, and the indirect effects of harm to organs such as the thyroid. We are especially concerned about radionuclides such as iodine-131, carbon-14, and tritium that could become part of the fetus in ways that could profoundly affect its well being. For instance, tritium, being a form of hydrogen, combines with oxygen to form water. Tritiated water behaves chemically like ordinary water. If ingested, a fraction of it becomes incorporated into the cells of the body, including genetic material. Such radioactive water also crosses the placenta. The potential for the resultant in-utero exposure to cause miscarriages, birth defects, and other health problems needs to be examined. The BEIR VII committee's evaluation of the risks of low-level radiation should include all such radionuclides and effects. If there are gaps in present knowledge, these should be identified clearly and their implications should be spelled out.
- **Effects of radiation on female fetuses:** Considering that ova are formed once per lifetime during females' fetal development, the Committee should evaluate the effects of radiation on the reproductive system of female fetuses and the possible effect of such radiation on the children of females irradiated in this way.
- **Effects of organically-bound radionuclides:** Radionuclides such as tritium or carbon-14 can become part of the DNA. Upon radioactive decay, they transmute into other elements. (Tritium becomes helium-3 and carbon-14

becomes nitrogen-14.) Such transmutation events could adversely affect the DNA. The potential health effects of such transmutations need to be evaluated.

- **Synergistic effects:** Exposure to radiation is sometimes coupled with exposure to other hazardous substances. The Committee should consider health effects caused by combined exposure to radioactive and non-radioactive substances. Special attention should be given to substances such as hormonally active agents that affect the hormonal system and the possibility that such disruption might increase the risk of cancer and other diseases arising from radiation exposure. Conversely, radiation exposure might damage the endocrine system, thereby increasing vulnerability to other disease-producing agents in the environment. The possibility of variability of such risks depending on age of exposure (and whether exposure takes place in-utero) should also be considered.

- **Data integrity and quality:** Worker dose records of the U.S. Department of Energy, and its predecessor agencies, are deeply flawed. The environmental contamination records are similarly deeply flawed. We know these things about the United States because much of the raw data record has become public through lawsuits, Freedom of Information Act requests, etc. Use of studies that accept official US worker or offsite dose estimates without evaluation of the raw data is highly questionable to say the least. Since the raw data in other countries are still largely secret, there is even less reason to accept them at face value. For instance, there is evidence that the health data in the former Soviet Union are questionable. The Committee should review these and related fundamental questions of data integrity and address whether any of this record is suitable at all for assessing the risks of low-level radiation, and if so how it should be used. The Committee should also address what criteria of data quality it will apply to the information contained in the studies it reviews. In this context, we do not believe that it will be enough to simply accept peer-reviewed studies as correct if they have not evaluated the soundness of the underlying official dose and health data. Finally the impact of misclassification of radiation exposures and health outcomes and health-related selection factors, should be considered in interpreting all epidemiological studies, including studies of A-bomb survivors.

- **Effects on various populations:** The concept of "standard man" or "average" is often used to set radiation protection standards. Given the potential large variability of actual health effects of radiation in various populations, the Committee should assess the errors in risk estimates produced by the use of this concept. For instance, the age-dependence of the dose response relationship for various health effects should be explicitly spelled out, not only for children, but also for older age groups. Another example is the potential variation in sensitivity to low-level radiation among individuals who are otherwise of similar demographic make-up.

In many of these areas, it may be that there is simply not enough knowledge to come to reliable scientific conclusions. In such cases, the Committee should clearly and frankly say so and recommend a research agenda. If possible, this should be accompanied by qualitative discussions of the mechanisms of potential health effects. It is of crucial importance to us that all areas where risk cannot be reliably calculated are clearly identified. If the types of risk can be qualitatively ascertained, the risks should be spelled out. If even the qualitative risks cannot be assessed, that conclusion would also be very material.

We have not discussed cancer-related issues above because we are presuming that the Committee will address the full range of relevant literature in regard to carcinogenic effects. It would be helpful if the committee published and updated frequently a list of the publications that it is reviewing, so that we may be able to follow the review and add to that list, should we feel that to be necessary or desirable.

We look forward to providing scientific input throughout the BEIR VII process and expect that the Committee will fully address the issues we have raised as seriously as it might were those same issues raised by a member of the Committee.

We appreciate the opportunity for public comment and ask that it be expanded as needed to fully accommodate the issues and evidence that we want to put forth. We look forward to your response. Do let us know if you have any questions or need more information. Please address your questions or responses to Lisa Ledwidge or Arjun Makhijani. Thank you very much.

Sincerely,

Lisa Ledwidge
Outreach Coordinator

Arjun Makhijani, Ph.D.
President

[The names of the other 130 signatories have been omitted for brevity. They are available on IEER's website at http://www.ieer.org.]